Ten Steps to Successful Exploration and Development*

Jeffrey B. Aldrich[1]

Search and Discovery Article #70346 (2018)**
Posted July 9, 2018

*Adapted from oral presentation given at AAPG 2017 Annual Convention and Exhibition, Houston, Texas, April 2-5, 2017

Best technical paper presented at the 2017 AAPG Annual Convention & Exhibition on behalf of the Division of Professional Affairs: "Ten Steps to Successful Exploration and Development"

[1]MHA, Denver, Colorado, United States (jaldrich@mhausa.com)

Abstract

The "Great Crew Change" has become the "Competence Train Wreck" due to the repeated personal management practices of our industry and again not anticipating the known volatility of commodity prices. Despite this, Hydrocarbon based energy will continue to comprise over 60% of the world's energy mix for at least the next half century and of that energy over half of it has yet to be found. Personal experience in working for National Oil Companies, Parastatals, Large Independent Oil Companies, small independents, as an independent, and as a consultant have given me the perspective of some of the best and some of the worst of the exploration practices the industry has to offer. From that experience I have my own set of Exploration Rules that I find work in all circumstances, from Conventional to Unconventional Reservoirs, from onshore to offshore, from giant fields to small single well strippers. This 10-step guide of practices will help the next generation avoid re-making many of the mistakes during the next cycle. Each Rule has multiple corollaries as well.

1) All maps (models) are wrong, drill on the least incorrect map.
2) Drill to make money – Let others drill for science.
3) If it is common knowledge it won't find new oil and gas.
4) If you can't visualize it, don't recommend it until you can.
5) It is better to be 100% lucky in an overlooked zone than 50% right in the target zone.
6) You don't know a lot more than you think you don't know.

7) Most Fields reserves grow through time - don't sell yourself short in the post-mortem.
8) Calculate probabilities, Define uncertainties – in order to reduce Risk.
9) The 80\20 Rule only works if the 20% won't kill you.
10) Oil and Gas is first found in the mind of Explorationists. Modified from W. Pratt.

Reference Cited

Human Development Report, 2003, Millennium Development Goals: A Compact Among Nations to End Human Poverty: Oxford University Press, New York, 34 p.

Ten Steps to Successful Exploration and Development

THE FUTURE OF ENERGY EXPLORATION:
Essential Tools for the Next Generation

Jeffrey B. Aldrich

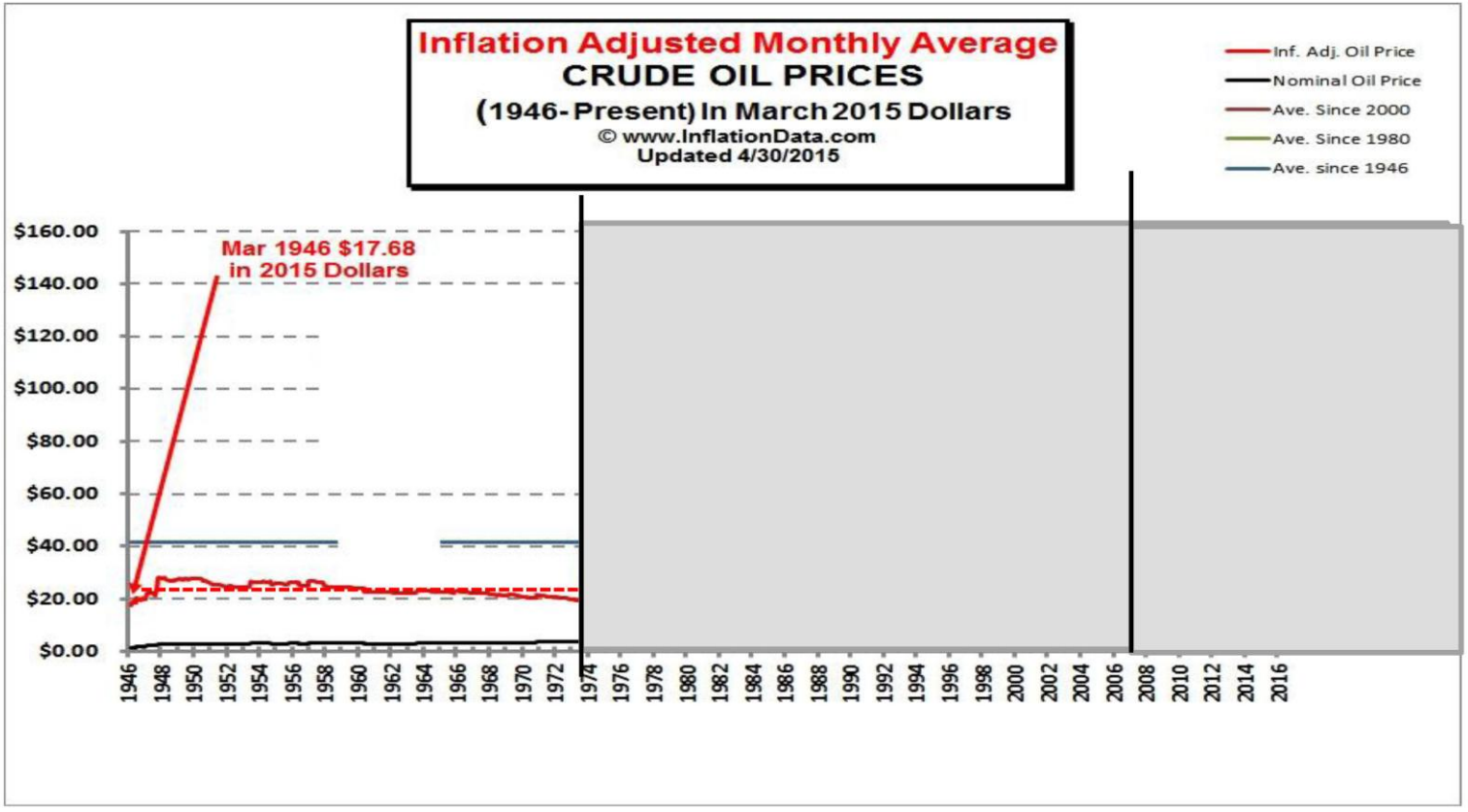
2017 AAPG Annual Convention and Exhibition
Houston Texas

730 17th St, Suite 410
Denver, CO 80202
01 303 277 0270 office
www.mhausa.com

A Story of 3 Generations in the Oil Patch

Post WWII Generation

Flat Price: Big E: 2D

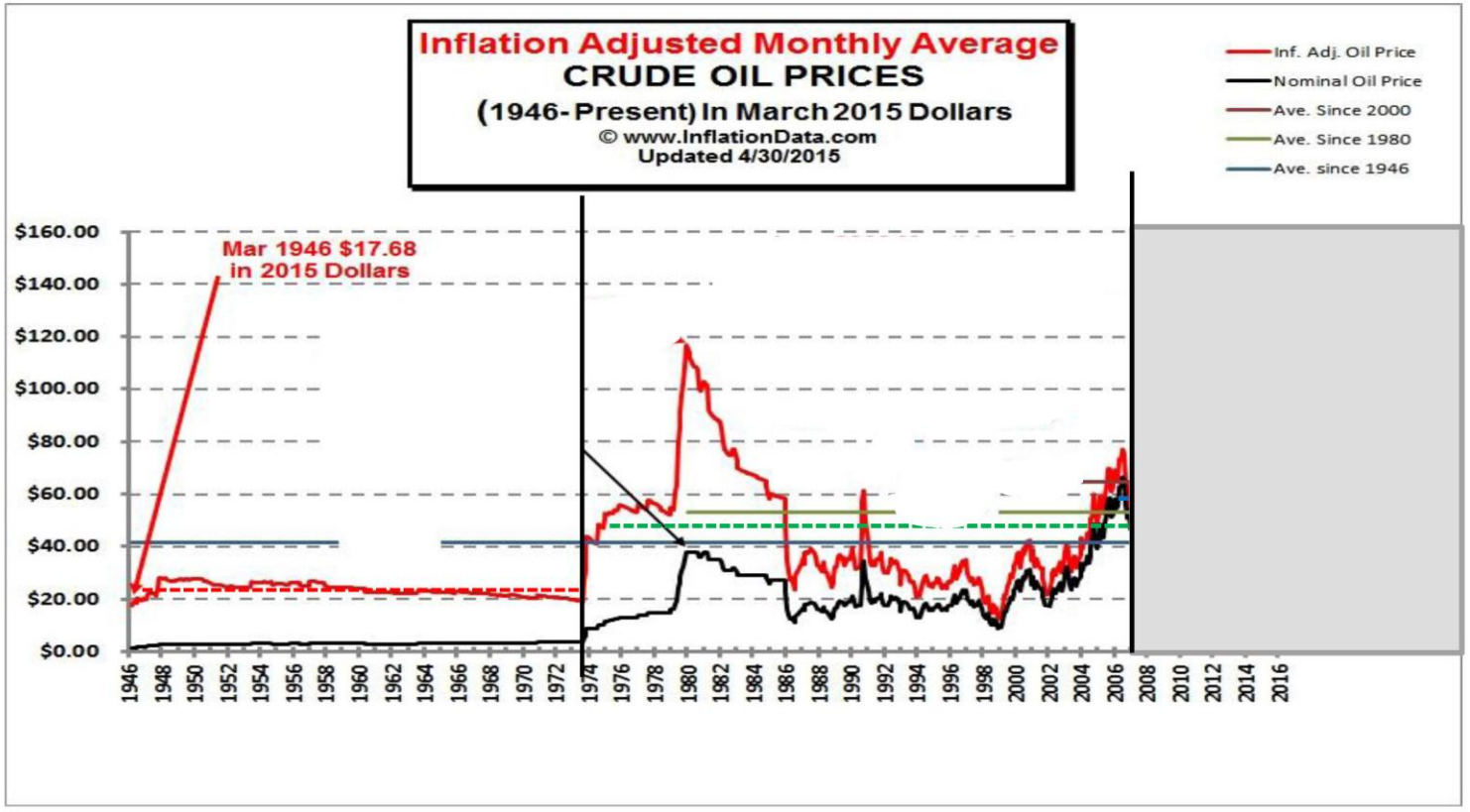


Presenter's notes: Post WWII Generation worked with a flat price and limited well control and only 2D data with no computers. This was the BIG E Generation and they found more oil and gas than all the generations before or after them.

A Story of 3 Generations in the Oil Patch

Post WWII Generation
Flat Price: Big E: 2D

My Generation
Uncertain Price: Little e: 3/4D



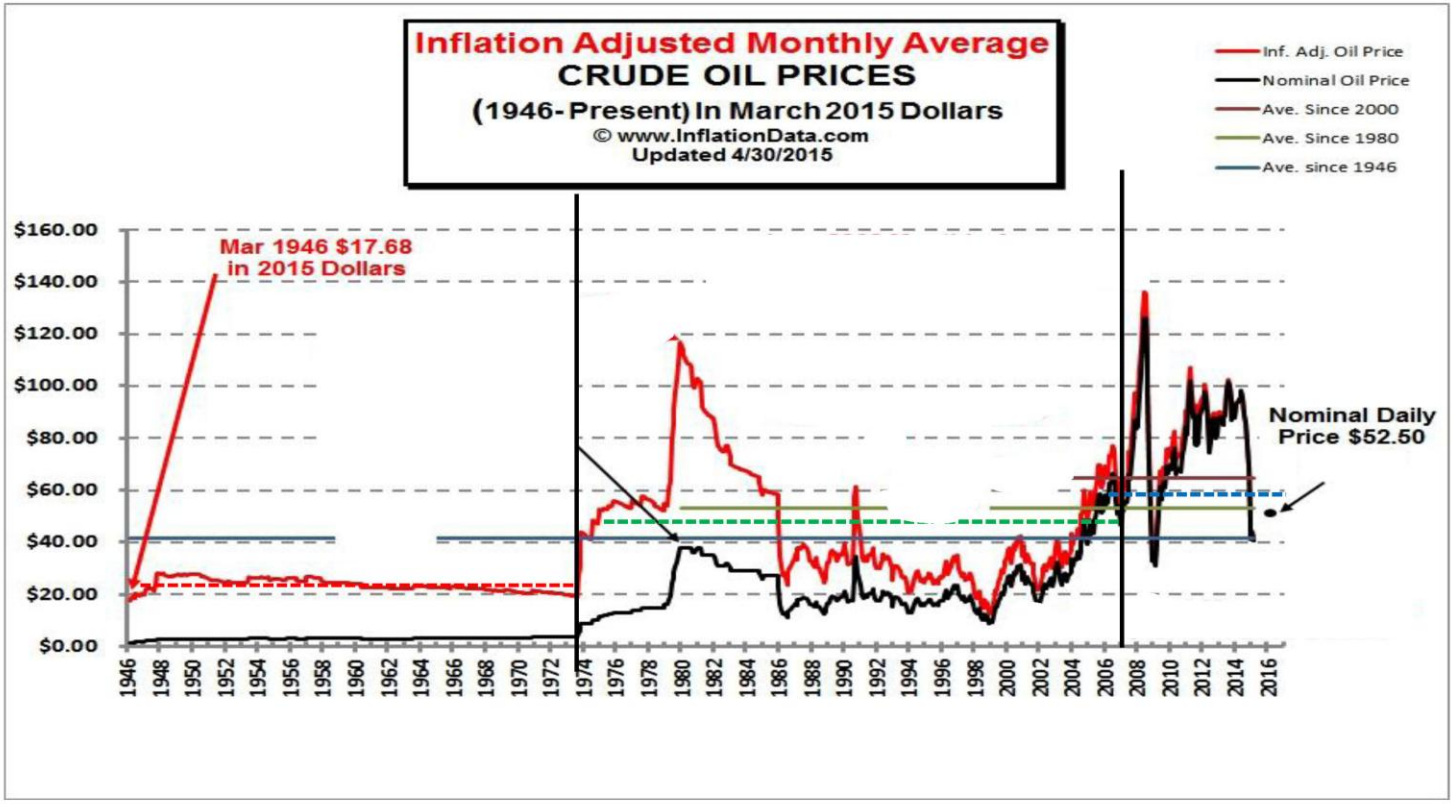
Presenter's notes: My Generation had very uncertain oil prices, the big OPEC price shock of the late 70's followed by the "LOWER FOR LONGER" twenty years from 86 to 06. We brought in computers, 3D and 4D and moved from silo teams to multi-discipline teams. We opened the deep water and brought in unconventionals.

A Story of 3 Generations in the Oil Patch

Post WWII Generation
Flat Price: Big E: 2D

My Generation
Uncertain Price: Little e: 3/4D

Your Generation
Volatile Price: New E:Techno



Presenter's notes: Today's generation has to deal with extreme volatility of oil prices. Price bands of greater than $150 to $20. This is an era of BIG DATA and many new technologies of mega and nano scale.

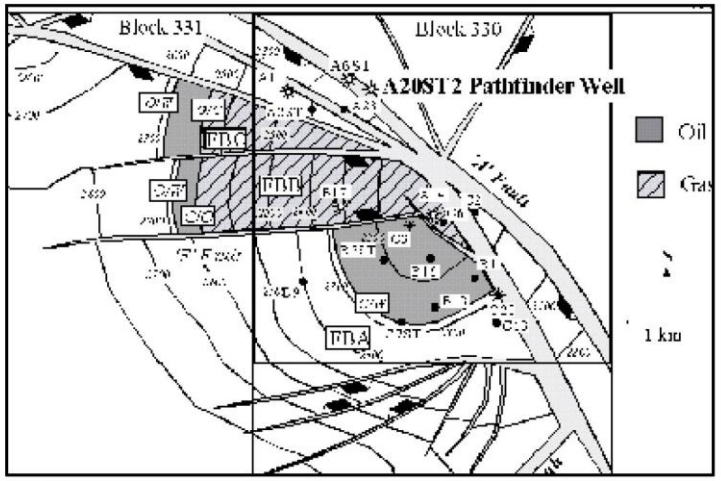
10 RULES THAT ARE NEVER TAUGHT IN SCHOOL

Presenter's notes: At my desk are my School Diplomas, My AAPG DPA Certification and my State Licensing. But I also have kept since my first years an evolving list of 10 RULES that were never taught in school but that I learned on the job. My First mentor had his 10 rules, some of mine are his and some are other ones that I have either picked up or learned along the years.

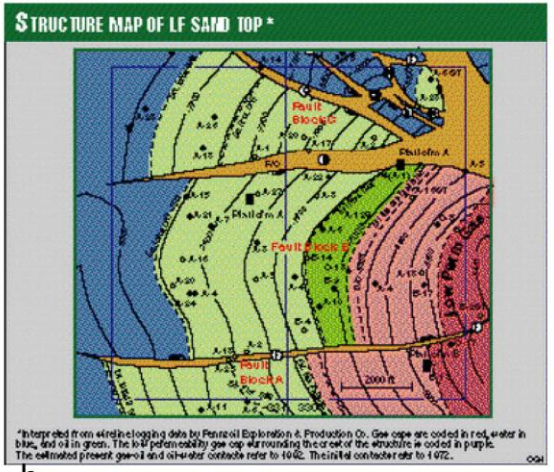
SOMETIMES THE QUESTIONS ARE COMPLICATED AND THE ANSWERS ARE SIMPLE.

Dr. Seuss

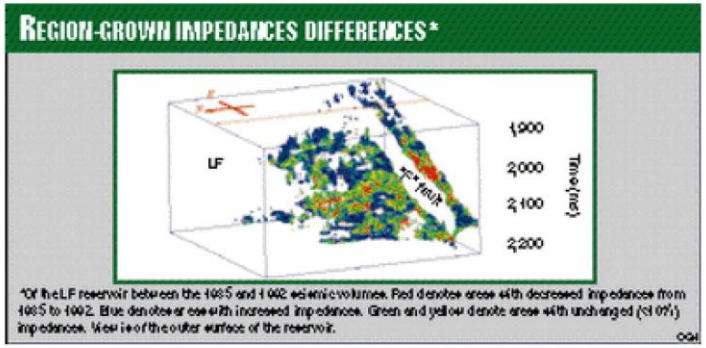
1: All Maps Are Wrong



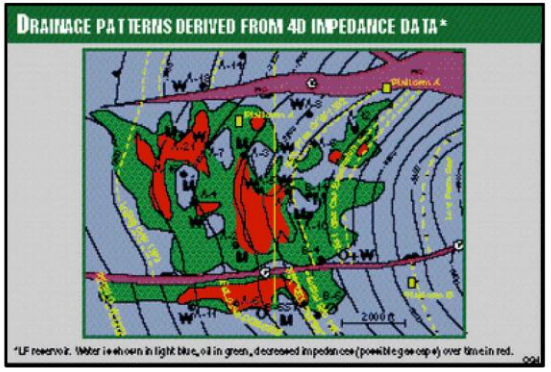
a.



b..



c.



d.

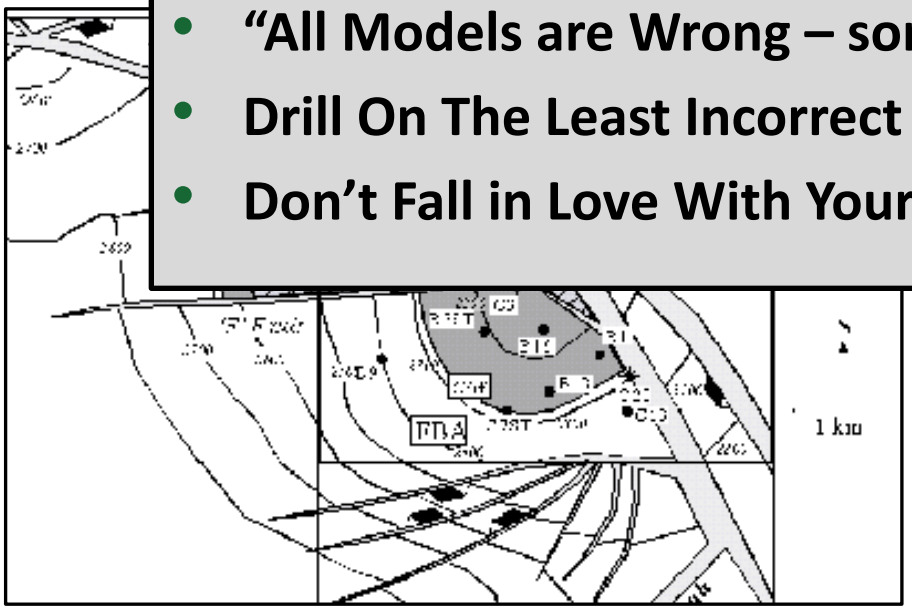
Presenter's notes: Here are 4 maps of Eugene Island 330 in the Gulf of Mexico. Map a) is made by the operator from 2D data after drilling the discovery well and several delineation wells prior to setting the first of several platforms. It is a structure map on the top of the LF series sands, one of the major producing horizons, and was thought to be the best and most accurate representation of the structure. It was the basis for a multi-million dollar investment decision. (*Presenter's notes continued on next slide*.)

(*Presenter's notes continued from previous slide*.)

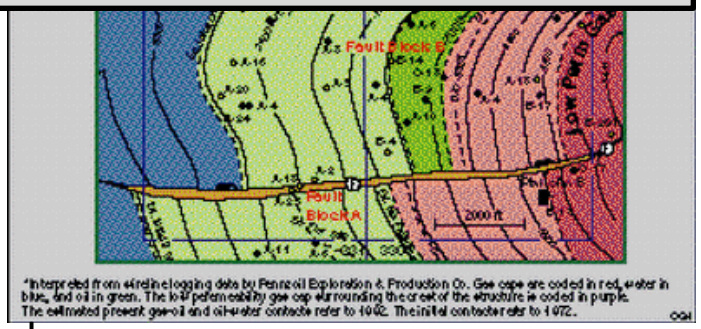
Map b) is the same horizon after the drilling of many development wells and a 3D seismic survey. The major faults have moved much further east and changed the gas/oil contacts. Map c) is an impedance volume that shows heterogeneities in the reservoir that are not shown in the original structure maps and map d) is a from a 4D seismic survey that indicates there is very uneven sweeping of the oil and gas phases from the reservoir. However, even this map has some assumptions in it left over from the original map as to the orientation, location, and throw of the radial faults that is most likely not accurate.

1: All Maps Are Wrong

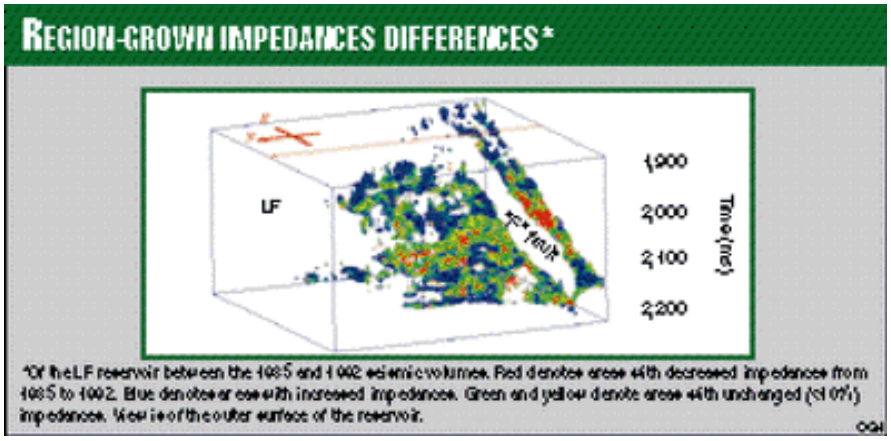
- "All Models are Wrong – some are Useful" – George Box 1976
- Drill On The Least Incorrect Map
- Don't Fall in Love With Your Own Map



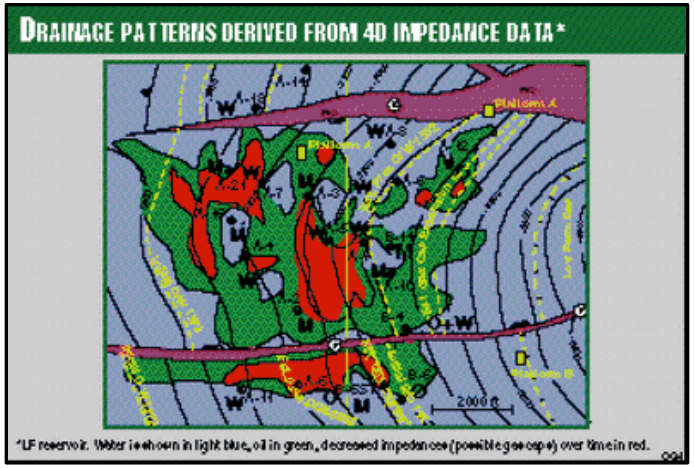
a.



b..

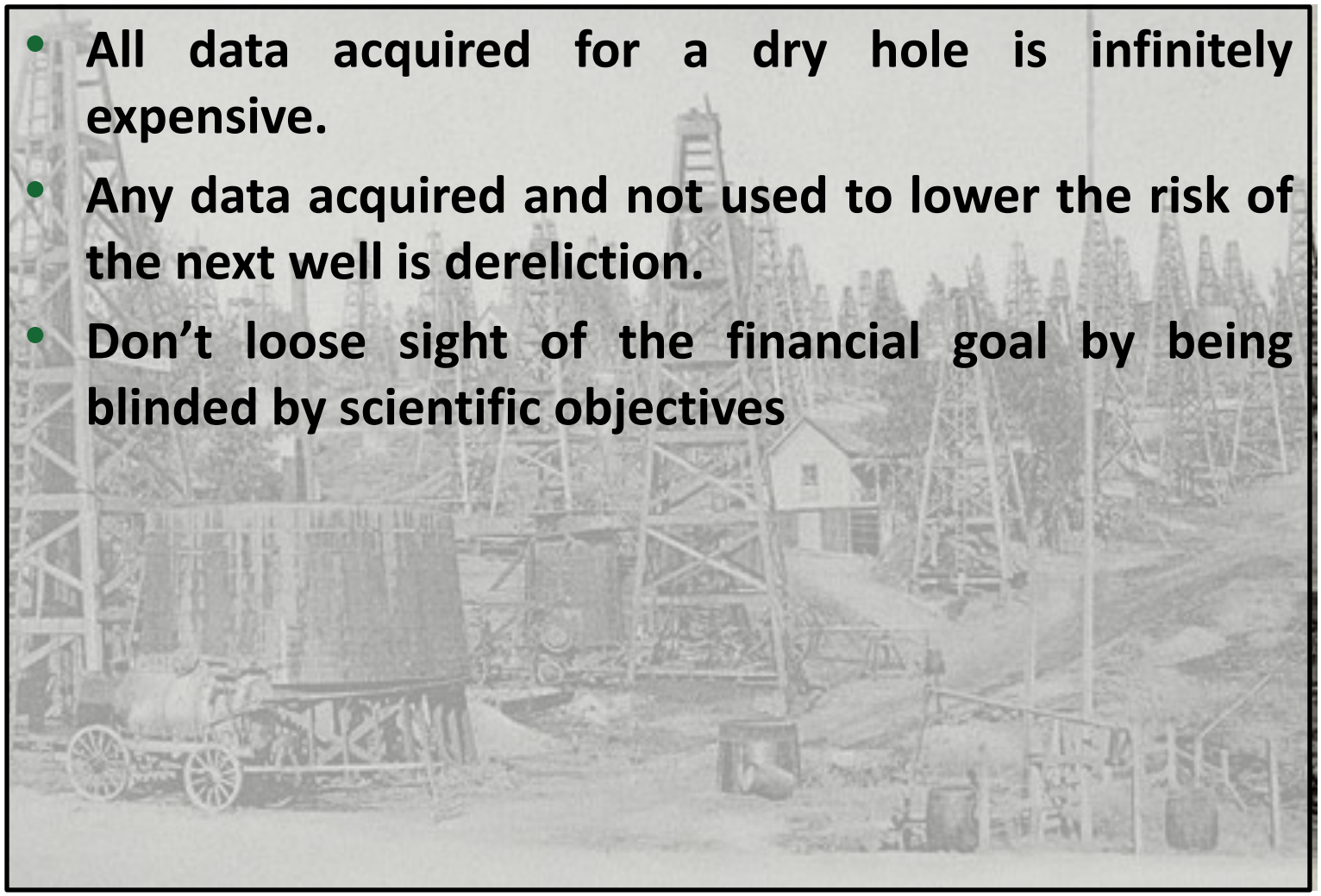


c.



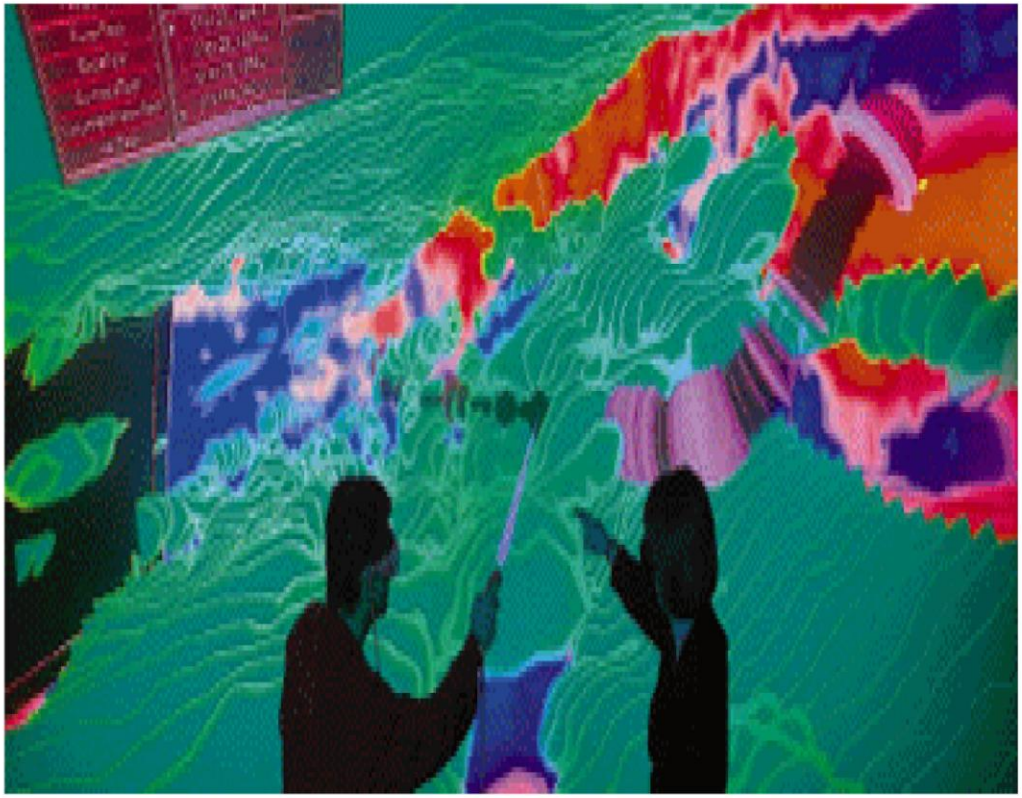
d.

2: Drill To Make Money – Let Others Drill For Science



- All data acquired for a dry hole is infinitely expensive.
- Any data acquired and not used to lower the risk of the next well is dereliction.
- Don’t loose sight of the financial goal by being blinded by scientific objectives

3: If You Can't Visualize It, Don't Recommend It Until You Can.



Presenter's notes:
Cindy Yielding of BP has a great term of "GEO-Nintendo" for those that spend hours building fantasy world of geo-models that have no basis in reality. Others try and let the computer "think" for them. Computers do not think. You have to be able to see, in your mind, the ancient fluvial or deltaic, or turbidite, or reef system. You have to see the burial process, the uplift, the generation, the migration, the entrapment.

3: If You Can't Visualize It, Don't Recommend It Until You Can.

There are tools to use (Seismic, Wells, Cross-Sections, Maps, Grav/Mag, Models etc.) but these are not substitutes for understanding but methods to use to come to an understanding.

A 3D model is no better than both the data and the CONCEPT that created it.

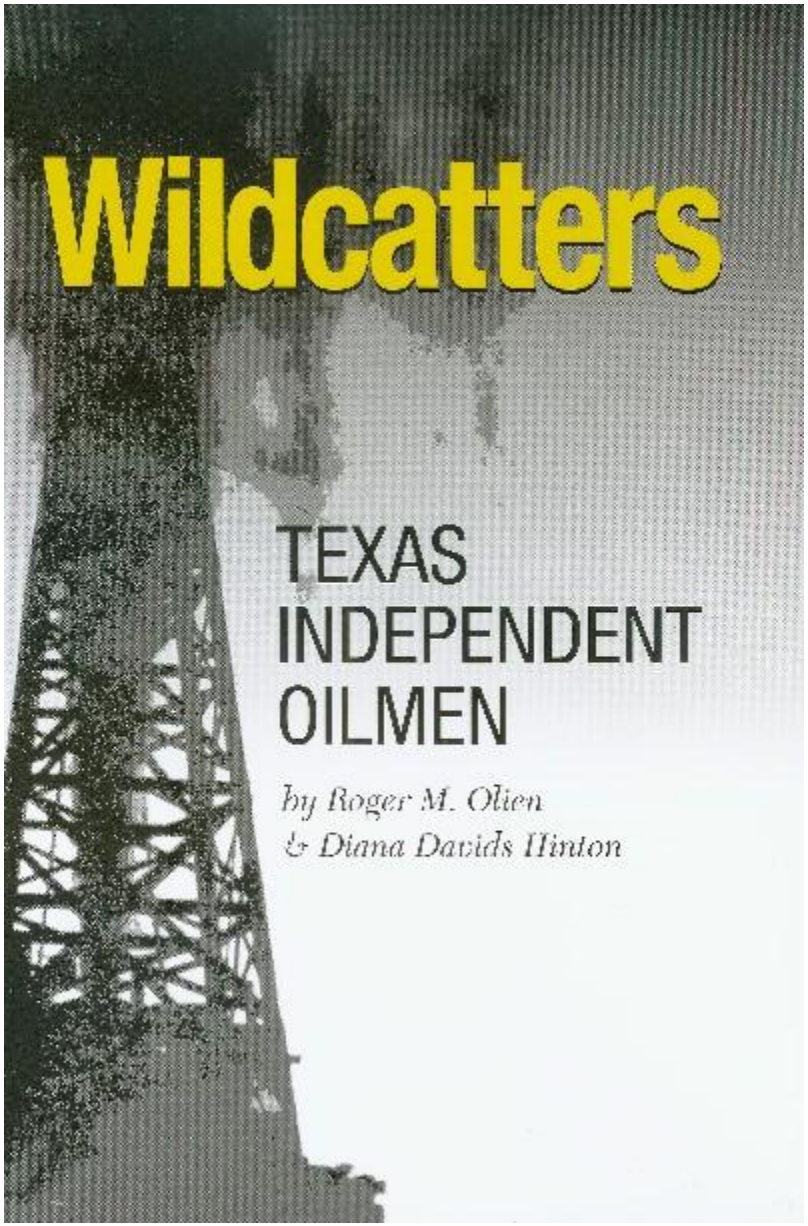
The 2 Things that most assist accurate visualizations are

1) Field Analogues

2) Hand Contouring

THINK AND WONDER, WONDER AND THINK. DR. SEUSS

Presenter's notes: By Field Analogues I mean having gone to outcrop and walked it – know the scale. And yes, I still hand contour.

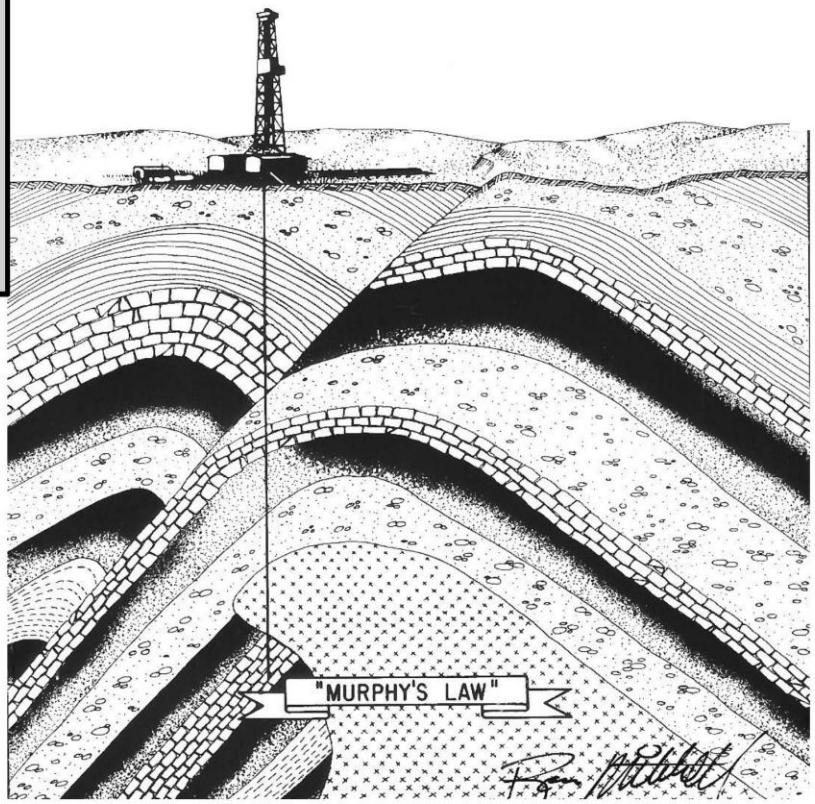


4: It Is Better To Be 100% Lucky In An Overlooked Zone Than 50% Right In The Target Zone.

5) You Don't Know A Lot More Than You Think You Don't Know.

Certainty does not exist in the future, only in the past!

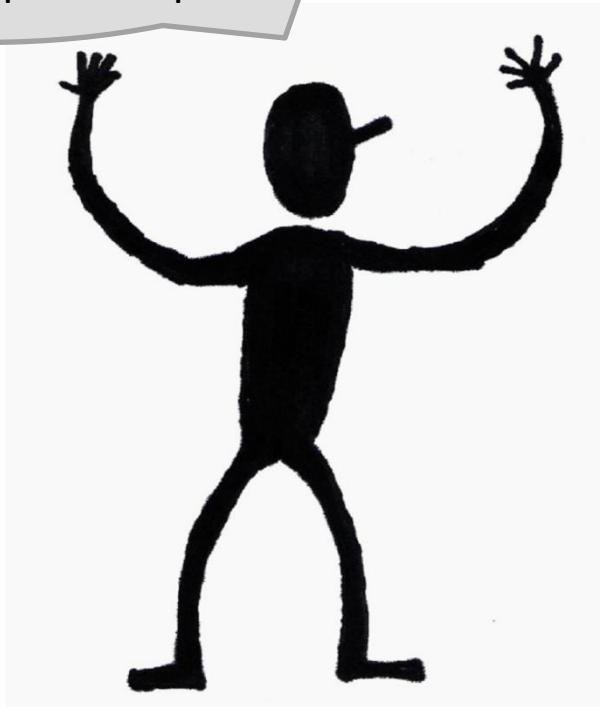
Jean LaHerrere 2007



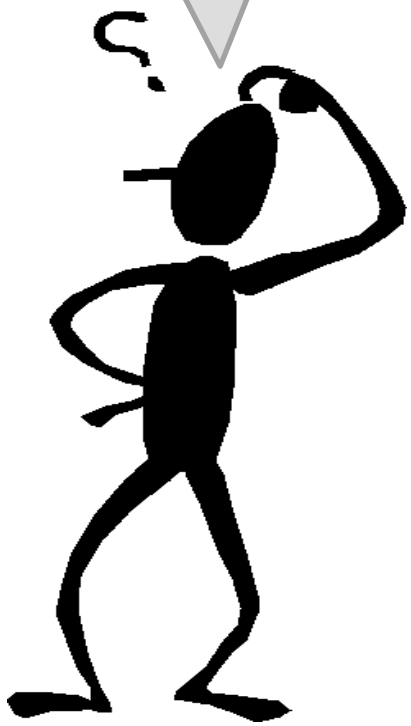
Presenter's notes: We can never be 100% certain, our data is never good enough for that! Go back to Rule 1.3 Don't fall in love with your own map!

6) Calculate Probabilities, Define Uncertainties In Order To Reduce Risk.

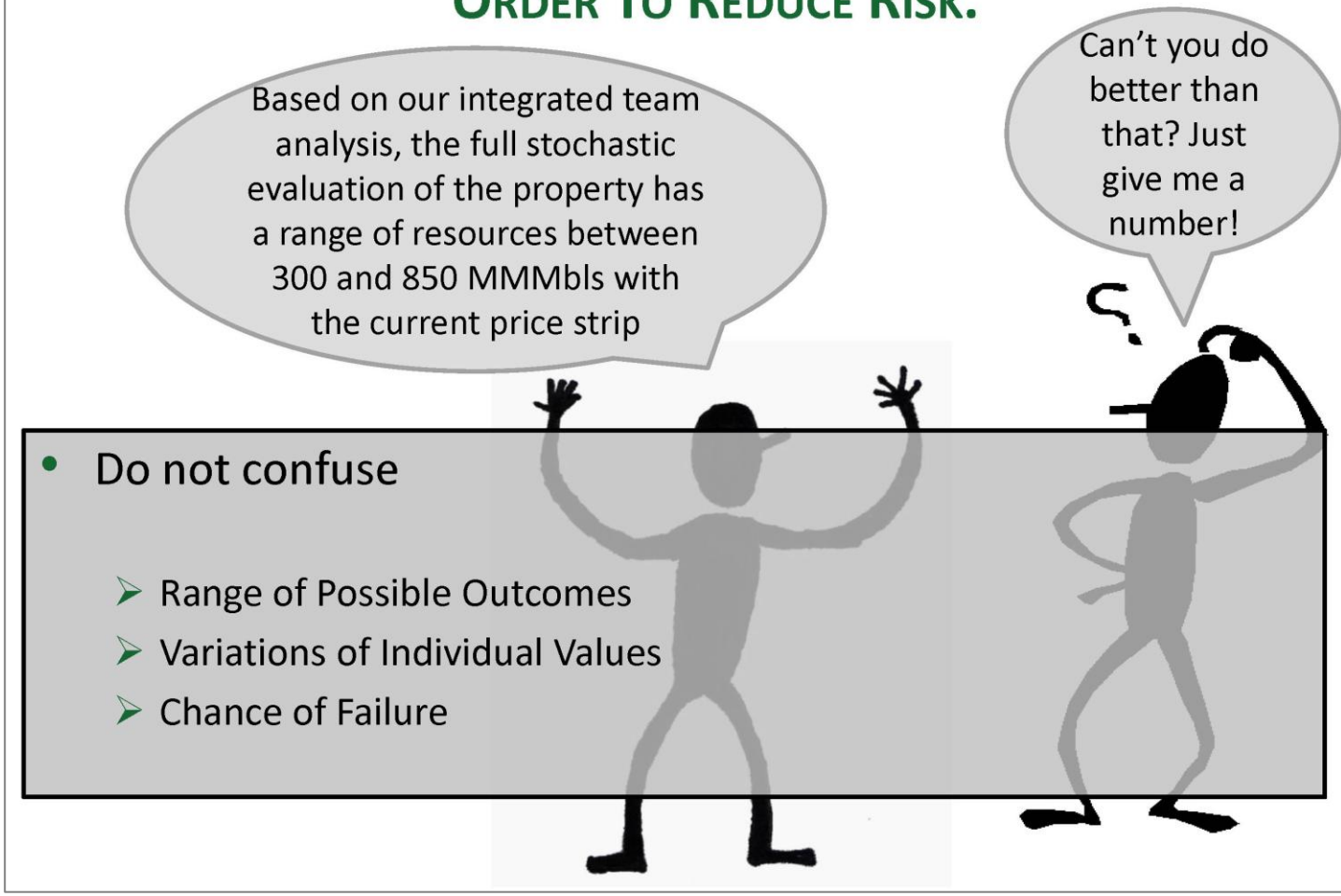
Based on our integrated team analysis, the full stochastic evaluation of the property has a range of resources between 300 and 850 MMMbls with the current price strip



Can't you do better than that? Just give me a number!



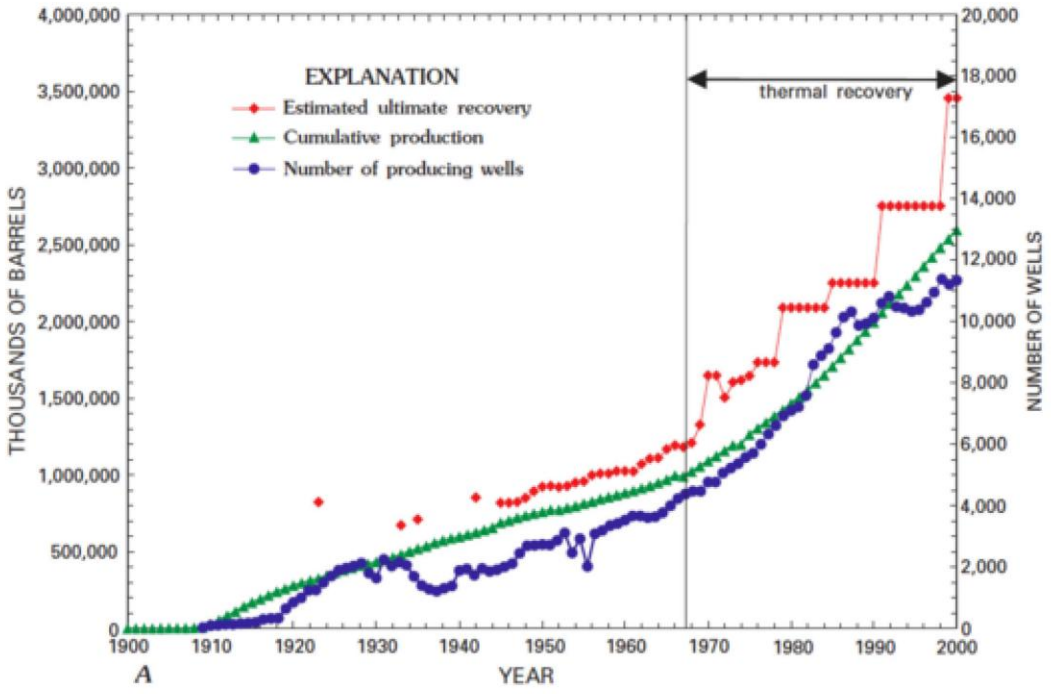
6) Calculate Probabilities, Define Uncertainties In Order To Reduce Risk.



- Do not confuse
  - Range of Possible Outcomes
  - Variations of Individual Values
  - Chance of Failure

Presenter's notes: Probability (Range of Possible Outcomes) \ Uncertainty (Variations of values of individual factors) \ and Risk (Chance of Failure) . Chance of Success is 1-Risk.

7) Most Fields Reserves Grow Through Time – Don't Sell Yourself Short In The Post Mortem.

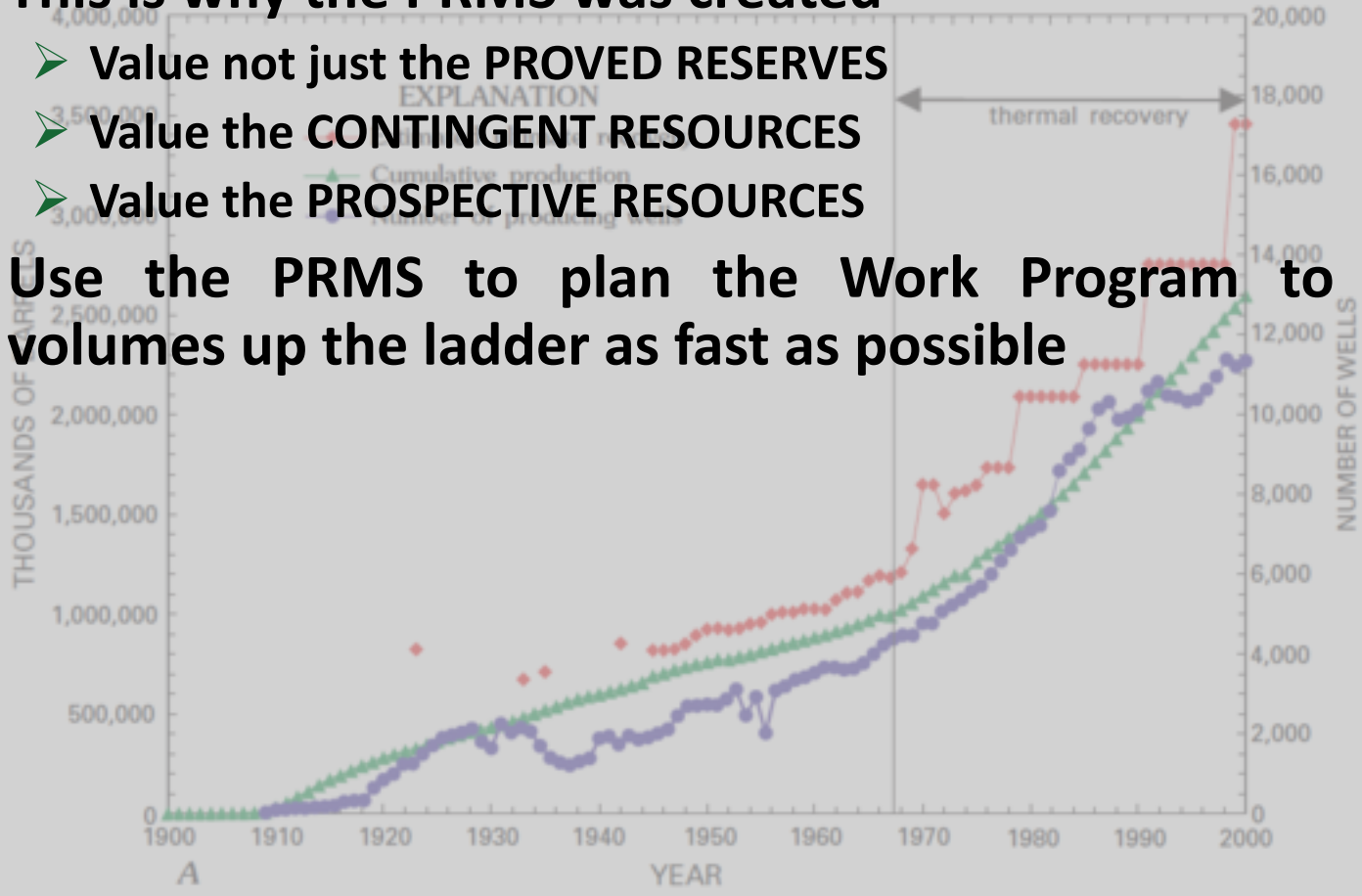


Midway-Sunset Field, Estimated Ultimate Reserves through Time

Presenter's notes: The key points here are that 1931 \ 1941 \ 1951 \1961 The EUR was always estimated to be about 20% more than the cumulative production at that point in time. They were always running at having just produced 80% of the EUR! When they started the Steam Flood they thought they could triple the remaining recoverable oil (.25MMBO to .75MMB0 from [EUR from 1MMBo to 1.5MMBo.]) However they have exceeded producing 2.5MMBo after the start of the steam flood – 1.7MMBo more than they predicted and 3.0+MMBo than the 1930-1950 reserve estimates.

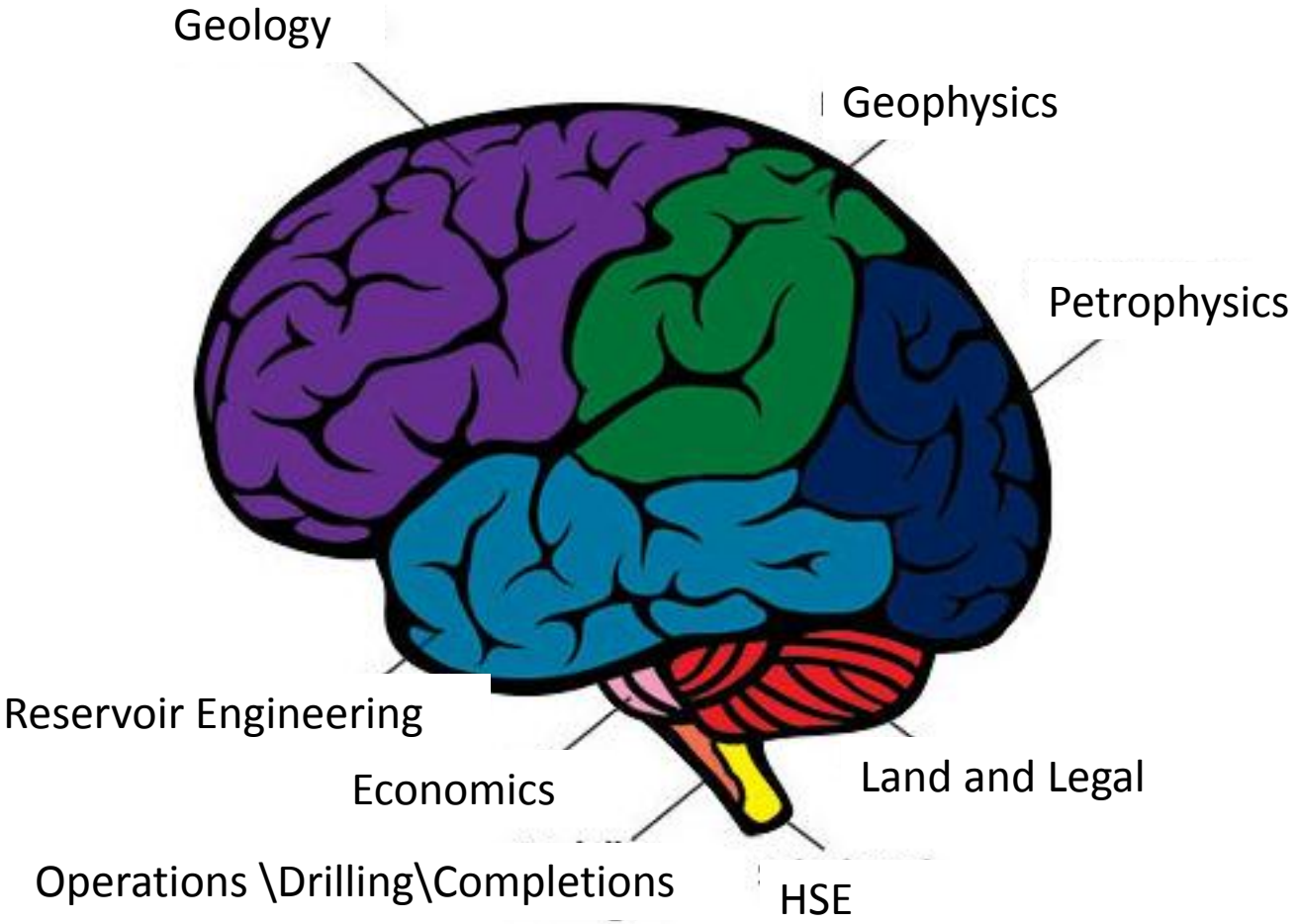
7) Most Fields Reserves Grow Through Time – Don't Sell Yourself Short In The Post Mortem.

- This is why the PRMS was created
  - Value not just the PROVED RESERVES
  - Value the CONTINGENT RESOURCES
  - Value the PROSPECTIVE RESOURCES
- Use the PRMS to plan the Work Program to advance volumes up the ladder as fast as possible



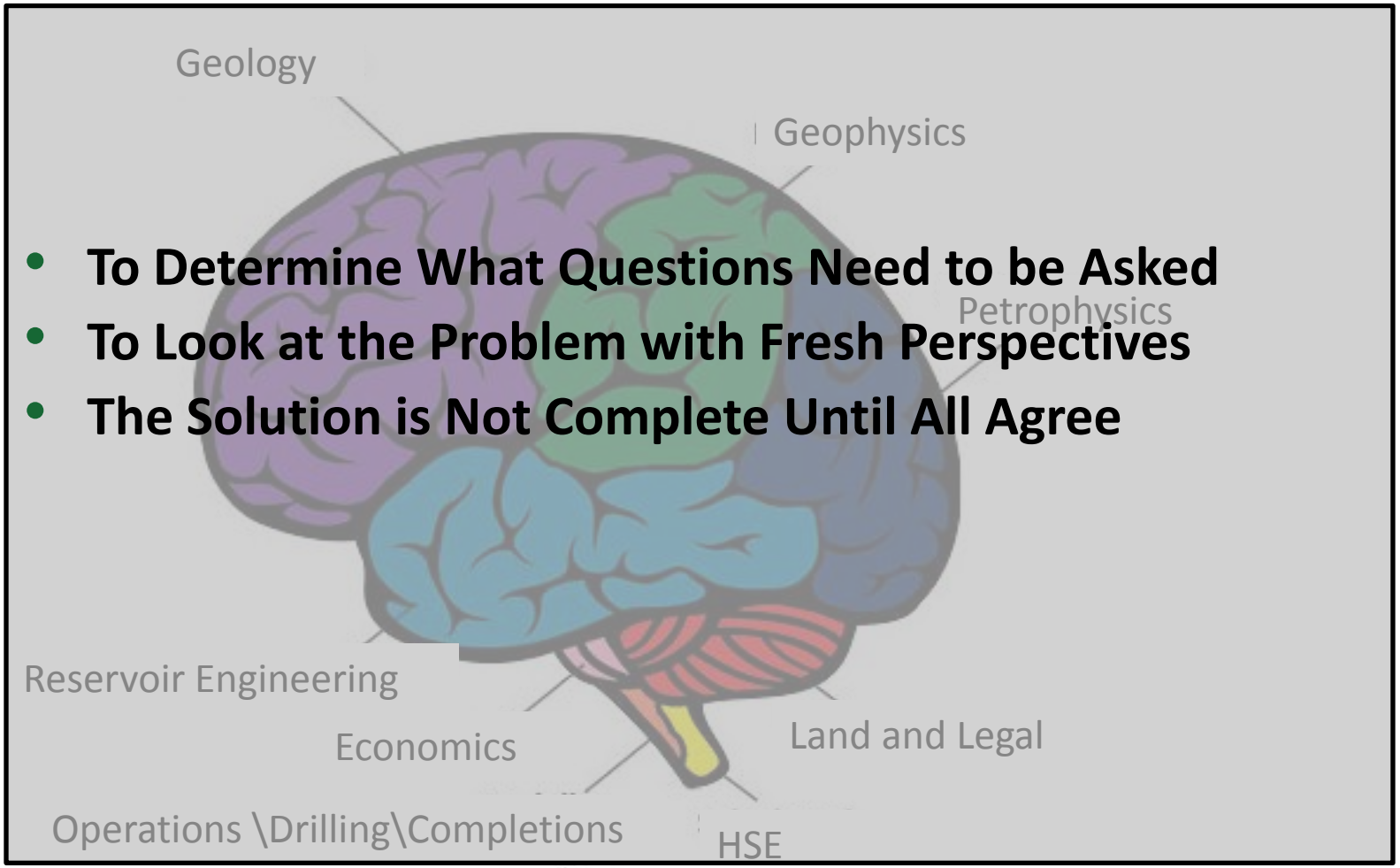
Midway-Sunset Field, Estimated Ultimate Reserves through Time

8) Multidiscipline Teamwork is the Best Solution.



Adapted from
John A. Masters

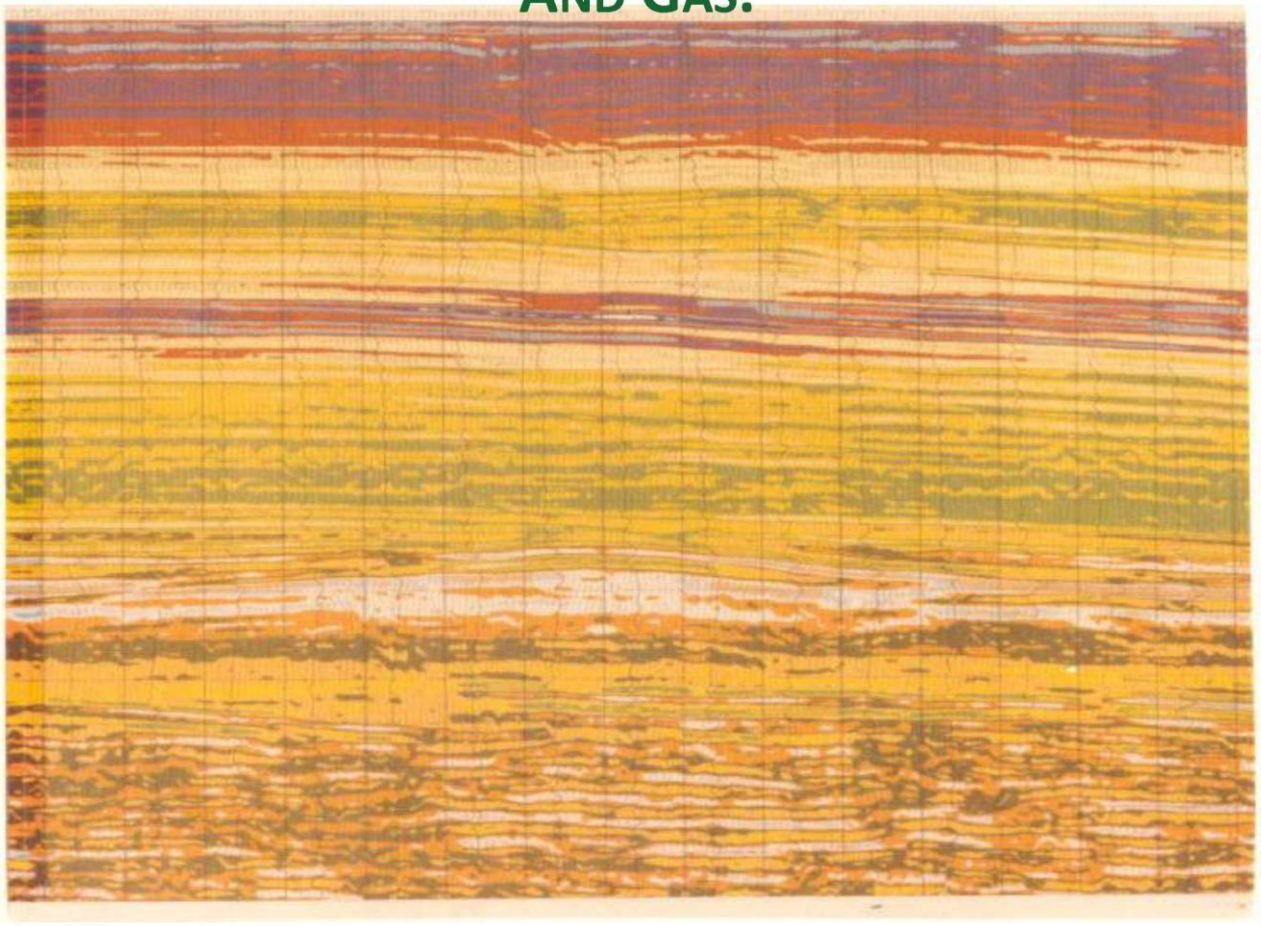
8) Multidiscipline Teamwork is the Best Solution.



- **To Determine What Questions Need to be Asked**
- **To Look at the Problem with Fresh Perspectives**
- **The Solution is Not Complete Until All Agree**

Adapted from
John A. Masters

9) If It Is Common Knowledge It Won't Find New Oil And Gas.



Presenter's notes: Do you see the giant gas field? The one with 64 "dry" wells in it? The Hint – it is NOT the Bright Amplitude associated with the positive structure in the bottom center of the image.

9) If It Is Common Knowledge It Won't Find New Oil And Gas.

- A) "Everyone already knows it"
- B) "Everyone knows it won't work"
- C) "It has already been looked at"

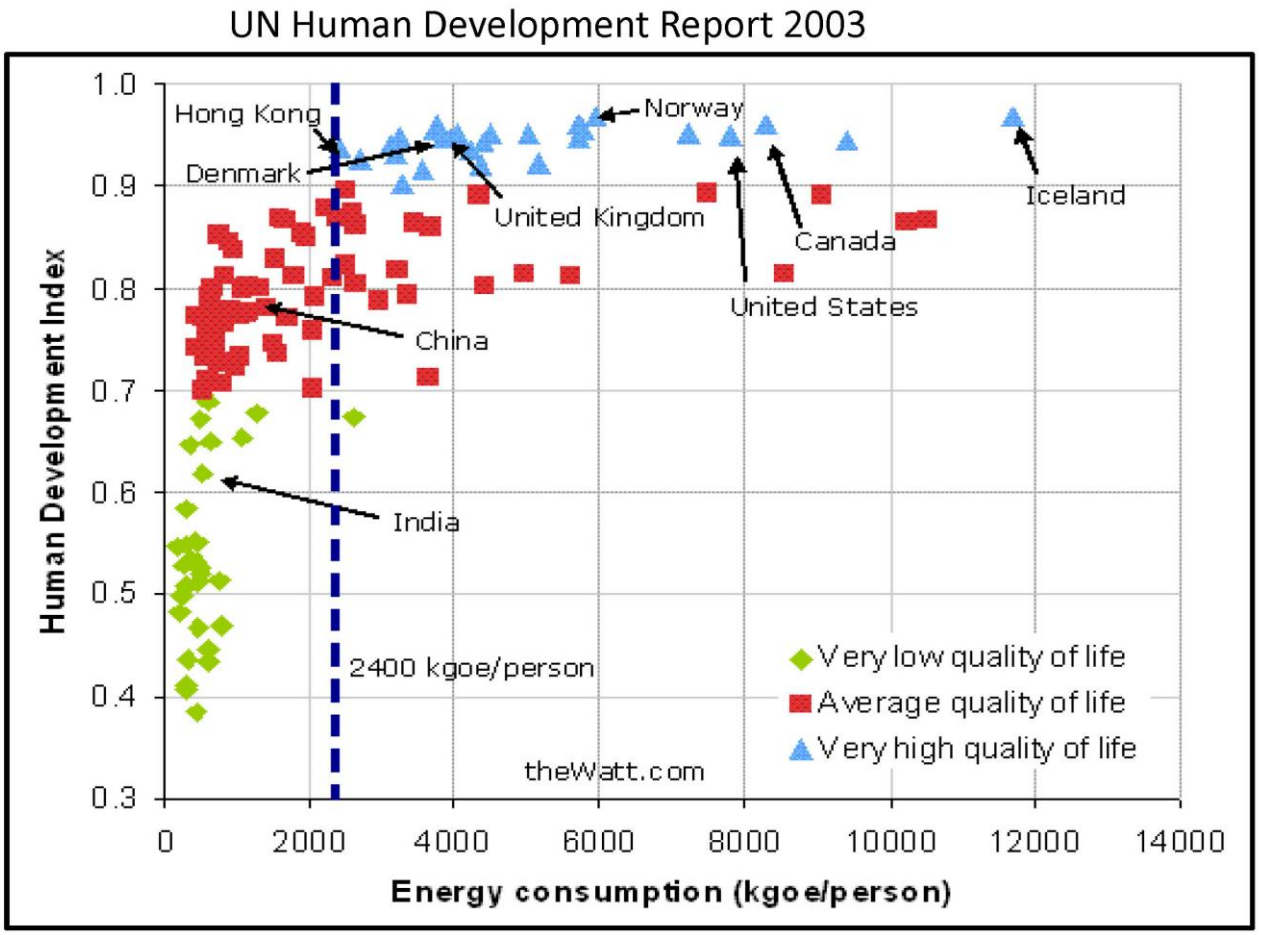
- All things told to John Masters about the Falther Formation that became the Elmsworth Field– the largest gas field in North America – after it had been penetrated by over 200 wells without being recognized as being productive.

- "Business as Usual" attitude and processes are not creative – question everything!

10) Hydrocarbons are First Found in the Minds of Explorationists (modified from W. Pratt)

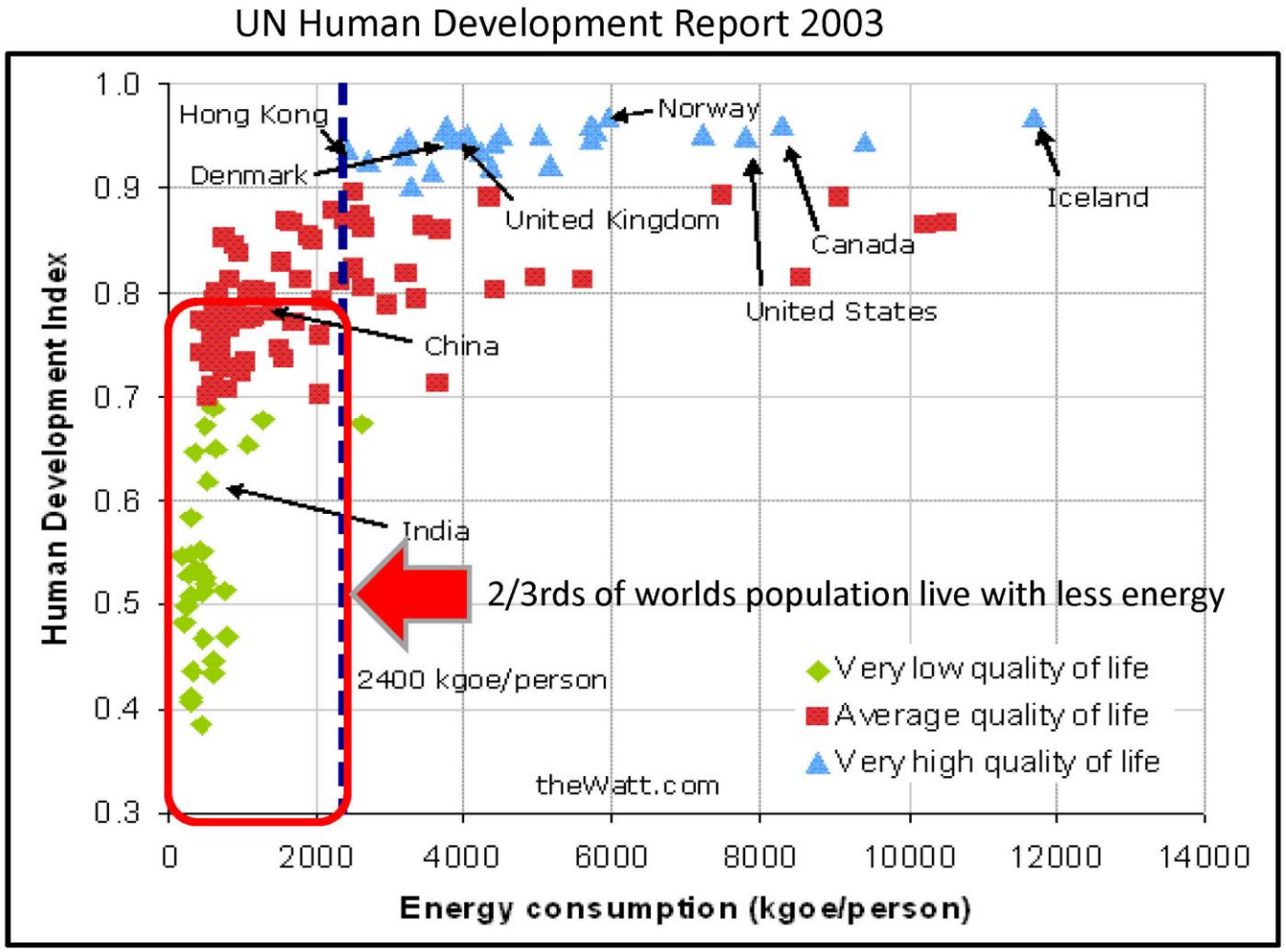
Think left and think right and think low and think high. Oh, the things you can think up if you only try. Dr. Seuss

THE CHALLENGE



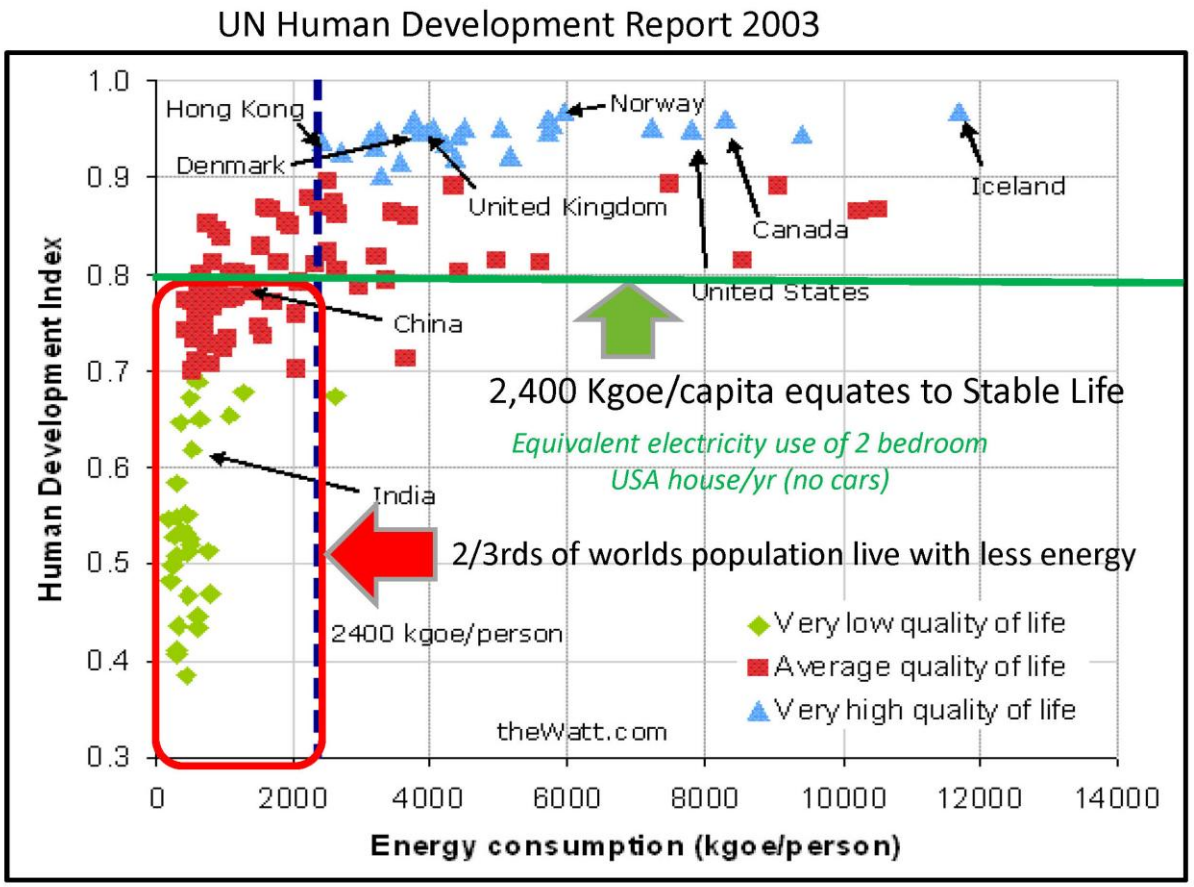
Presenter's notes: In the UN Human Development Report – I am using 2003 data but there are several versions – Nothing has a better correlation to the Human Development Index (HDI) than Energy Consumption. Not GDP, Not Free Markets, Not Education, but Energy Consumption. The HDI is the best indicator of birth rate, education, access to clean water, nourishment, etc.

THE CHALLENGE



Presenter's notes: 2/3rds of the worlds population is in "ENERGY POVERTY" below the UN Standard for Average Quality of Life – 2,400KGOE/pax/annum

THE CHALLENGE



HOW DO WE BRING THEM TO 2,400 KGOE?

Presenter's notes: This is the challenge of the next generation. 2/3rds of the world now sees how the other 1/3 lives and wants that life. Yes many in the developed world can and should conserve but that won't provide enough energy for all. There will be a need for energy geoscientists for many generations to come.

ACKNOWLEDGEMENTS

The author wish to thank MHA Petroleum Consultants, LLC. for the time and permission to prepare and present this talk.

However – the contents, opinions and thoughts of this presentation are the authors alone and may not reflect the opinions of MHA Petroleum Consultants.

The “10 Rules of Successful Exploration and Development” are available by contacting the author through MHA Petroleum Consultants.